What Would a Warp Drive Actually Look Like? Visualizing Warp-Drive Spacetimes in General Relativity

Rabbel, Mads (School: Gymnasium Reutershagen)

Warp drives are hypothetical solutions to Einstein's equations that might allow superluminal travel by expanding space behind a spaceship and contracting it in front. This project investigates the warp-drive metrics proposed by Miguel Alcubierre, Chris Van den Broeck and Erik Lentz with a main focus on visual representation. Two video clips were created to illustrate the expansion in front of and behind an Alcubierre spacecraft while varying the velocity and the sigma parameter. For Van Den Broeck's metric, an isometric embedding into three-dimensional Euclidean space was constructed—similar to Flamm's paraboloid. The result provides good intuition for the influence of the essential parameters. The core of this project is a relativistic ray-tracing algorithm that simulates how an outside observer would perceive an Alcubierre warp drive or a Lentz warp drive. In the results for the Alcubierre drive, the simple, spherically symmetric shape of the metric becomes visible. The results for the Lentz drive show more complicated curvature effects for more complex warp-drive metrics.

Awards Won: